Note on the Transit of the Planet Mars and its Satellites across the Sun's disc, which will occur for the Planet Jupiter and its Satellites on April 13, 1886. By A. Marth.

In a "Note on the Transit of the Earth and Moon across the Sun's disc as seen from *Mars* on Nov. 12, 1879," published in vol. xxxix., the statement may be found (on page 487) that the last transit of *Mars* for *Jupiter* had occurred on Aug. 13, 1785, and that the next one would take place, I presumed, in April 1886. Considering the rarity of the event, I have thought it worth the trouble to compute the circumstances of the case properly, in order to gain some distinct notions of the details of the occurrence. But as the data and explanations necessary for verification and more detailed computations would require more space than this note is intended to occupy, I content myself with merely communicating some of the deduced results.

The transit will begin on April 12 at $20^h\ 35^m$ Greenwich Mean Time with the ingress of *Deimos* upon the Sun's disc for the preceding edge of *Jupiter's third* satellite, and will end on April 13 at $18^h\ 17^m$ Greenwich Mean Time, with the egress of *Deimos* for the following edge of the *second* satellite; so that the whole transit will last for *Jupiter's* system 21 hours 42 minutes, during which interval *Phobos* will have made two full revolutions and three-quarters, and *Deimos* nearly three-quarters of a revolution. For *Jupiter* itself the transit will begin on April 13 at $0^h\ 27^m$ with the ingress of *Deimos* at sunset for a point in 16° of jovicentric northern latitude, and in 108° or 175° western longitude, according as the longitudes are reckoned from the Zero-Meridian in the first or second system of longitudes adopted in the ephemeris published in vol. 45, p. 504 ff. The transit will end at $16^h\ 2^m$ with the egress of *Deimos* at sunrise for a point in 14° of jovicentric northern latitude and in 138° or 200° of longitude, so that for *Jupiter* the whole transit of *Mars* and its satellites will last 15 hours 35 minutes, during which interval *Jupiter* itself will have performed one full rotation and a half. With the exception of the small region within 2° of the north pole, the whole surface of *Jupiter* will have come into sunlight, while *Mars* and its satellites are before the disc; for a region extending approximately from longitude 294° to 312° in the first system of longitudes, or from 356° to 19° in the second system, or for a region including the neighbourhood of the great spot, the ingress of *Mars* and of both satellites will take place in the evening of one Jovian day, the middle passage in the middle of the next day, and the egress in the morning of the third Jovian day.

The Greenwich mean times of ingress and egress for the four satellites of *Jupiter* and for the points of first and last touch of the planet with the contact-cones are given below. The angles of position are those of the centre of *Mars*, as seen from *Jupiter*,

and as reckoned from the point which is in the direction of the north pole of *Jupiter's* equator. The jovicentric apparent diameter of the Sun is 352″·57, that of *Mars* 2″·46; the greatest elongation of *Phobos* from the centre of *Mars* is 3″·40; that of *Deimos* 8″·50. At 8h 14m the centres of *Mars* and of the Sun will be jovicentrically at their least apparent distance 40″·30.

Ingress of		*Deimos.*	*Phobos.*	*Mars.* Ext. C.	*Mars.* Int. C.	Angle of Position.
		h m	h m	h m	h m	°
for Sat. III.	April 12	20 36	20 56	20 46	20 52	74·6
Sat. IV.		21 38	21 58	21 54	22 1	75·1
Sat. II.	April 13	0 3	0 20	0 26	0 34	75·8
♃ prec. l.		0 27	0 39	0 45	0 51	79·6
Sat. I.		still eclipsed		1 8	1 16	76·5
♃ foll. l.		1 6	1 22	1 24	1 30	78·4

Egress of		*Phobos.*	*Mars.* Int. C.	*Mars.* Ext. C.	*Deimos.*	
for Sat. III.	April 13	10 34	10 25	10 32	10 43	285·3
Sat. IV.		14 0	14 1	14 9	14 29	285·9
♃ prec. l.		14 53	14 58	15 5	15 22	286·1
♃ foll. l.		15 33	15 38	15 44	16 2	284·9
Sat. I.		16 43	16 42	16 48	17 1	283·3
Sat. II.		18 6	17 56	18 3	18 17	284·1

The following statements may probably interest some readers.

During the sixty years from 1830 to 1890 there will have taken place seventeen transits of *Mercury* over the Sun's disc for *Jupiter* and its satellites, against seven as seen from the Earth. The dates and the heliocentric longitudes are :—

1833 Dec.	1·8	34·1	°	1863 Aug.	22·7	°	212·5
1834 Mar.	1·2	42·3		— Nov.	21·0		219·4
1840 Jan.	15·9		215·6	1869 July	25·5	36·4	
1845 Sept.	19·9	32·2		— Oct.	22·9	44·5	
— Dec.	18·3	40·3		1875 Sept.	8·9		217·8
1851 Nov.	3 8		214·0	1881 May	13·7	34·5	
1852 Feb.	2·0		220·9	— Aug.	11·0	42·7	
1857 July	9·0	30·3		1887 Aug.	27·8		216·1
— Oct.	6·4	38·4					

Venus has during these sixty years crossed the Sun's disc for *Jupiter* eight times :—

1834 Dec.	7·5	67·4	°	1858 Apr.	16·7	55·7	°
1840 Oct.	2·9		235·7	1864 Oct.	5·3		244·1
1846 Aug.	12·1	61·6		1876 June	10·3		239·0
1853 Jan.	30·3		249·2	1882 Apr.	19·7	65·2	

As regards the Earth, the oppositions of *Jupiter* to the Sun or the inferior conjunctions of the Earth recur at intervals of eighty-three years in approximately the same ecliptical longitudes. Nearly one-half of this period of eighty-three years is barren of transits, while during the other half there occur usually eight transits. A cycle of transits ended with that which occurred 1765, Jan. 5·0, in hel. longit. 105°·5. After an interval of forty years without transits the Earth and Moon crossed the Sun's disc for *Jupiter* on the following dates :—

1806 June	25·2	in hel. long.	273°·4	1811 Dec.	23·3	in hel. long.	91°·2
1818	30·1		278·1	1823	28·0		96·1
1830 July	5·0		282·9	1836 Jan.	1·7		100·9
1842	10·0		287·8	1848	6.1		105·1

or at intervals of alternately five and six synodical revolutions. After a barren interval of forty years, a similar cycle of transits will begin with that of 1889 June 24·3 in long. 273°·4, and end with the transit of 1931 Jan. 6. In the course of time changes occur in this arrangement. The transit next preceding that of 1765 Jan. 5 occurred, not in 1759, but 1752 Dec. 31·3, in hel. long. 100°·7 or near the same node, the conjunction of 1759 July 9·6 in long. 287°·6 being merely a close conjunction, the Earth and Moon passing for *Jupiter* just outside the Sun's disc.

So much about the transits of the inferior planets which occur for *Jupiter* and its satellites. Now a few remarks about the occasions when *Jupiter* itself crosses the Sun's disc for the three outer planets.

Since 1690, when *Uranus* was first observed, there have already occurred two transits of *Jupiter* for *Uranus*—at midsummer 1706, and 1789 May 10 in hel. long. 124°·2. The next two transits, I presume, will take place near the other node in the years 1914 and 1997.

As regards *Neptune*, it would demand stricter computations than I have made, and would probably require improved tables, to state decisively whether the conjunctions of the years 1613 and 1779 in the past and those of the years 2022 and 2188 in the future are such close conjunctions as to produce actual transits of *Jupiter* for *Neptune*.

However, the chief question is that concerning transits of *Jupiter*, which may occur for *Saturn*, and, what for observers on the Earth is of greater interest, geocentric occultations of *Saturn* by *Jupiter*. The closest conjunction at which the two planets have been seen since the invention of the telescope was the geocentric conjunction of February 8, 1683, in long. 136° ·7, when the two planets in their retrograde courses passed one another at a distance of 11′. The conjunction was the middle one of a triple conjunction, such as had not occurred since 1425, and as will not occur again till 1940, as I mentioned in an oral communication

made at one of the meetings of the Royal Astronomical Society in 1877 (see the *Astronomical Register*, vol. 15, p. 159). A closer conjunction, both heliocentrically and geocentrically, than that of 1683, was that of July 1623, which was, however, invisible, as it took place not long before the conjunctions of the two planets with the Sun. After twenty-two heliocentric conjunctions since 1623, the next minimum conjunction will occur in May 2080, in which year the two planets will come into opposition to the Sun early in August. The following minima will occur in May 2477, January 2875, &c. An examination of the question, made with the help of Le Verrier's tables in 1878, has satisfied me, that during the next two thousand years as well as during the last two thousand years, or during a full period of four thousand years, no conjunction of the two planets can be found, which takes place so near to the line of nodes of their orbits as to produce a transit of *Jupiter* across the Sun's disc for *Saturn*, or an occultation of *Saturn* by *Jupiter* for observers on Earth.

Ephemeris of the Satellites of Mars, 1886. By A. Marth.

The values of the longitude of the node N and of the inclination J of the orbit of *Deimos*, in reference to the plane of the Earth's equator, employed in the following ephemeris, are

$$N = 49^\circ\cdot533, \qquad J = 36^\circ\cdot037.$$

The assumed proportion of the mass of the Sun to that of *Mars* is

$$\odot = 3095000.$$

The orbital longitude of *Deimos*, reckoned from the node, is

$$u_2 - 141^\circ\cdot43 + 285^\circ\cdot1616\,(t - t_0),$$

the epoch t_0 being 1886, March 14·0 Gr.

Phobos is assumed to move in the plane of the orbit of *Deimos*, and its longitude is taken to be

$$u_1 = 56^\circ\cdot54 + 1128^\circ\cdot8492\,(t - t_0),$$

its value being a little uncertain, as only two position-angles observed during the last opposition are available.

The periods of the sidereal revolutions corresponding to the assumed daily rates of motion are for

Phobos $7^h\ 39^m\ 13^s\cdot72$,

and for

Deimos $30^h\ 17^m\ 54^s\cdot99$.

a, b major and minor semi-axes of the apparent ellipses described by the satellites.